This document contains Part 2 (pp.21–36) of Chapter 1 of the National Coastal Condition Report III.

The entire report can be downloaded from http://www.epa.gov/nccr

National Coastal Condition Report III

Chapter 1: Introduction

Part 2 of 2

December 2008

Coastal Habitat Index

Coastal wetlands are the vegetated interface between the aquatic and terrestrial components of coastal ecosystems and serve many purposes. Wetlands are beneficial because they can filter and process residential, agricultural, and industrial wastes, thereby improving surface water quality. Wetlands buffer coastal areas against storm and wave damage. Wetland habitats are critical to the life cycles of fish, shellfish, migratory birds, and other wildlife. Many species of commercial and sport fish spend a portion of their life cycles in coastal wetland and estuarine habitats. Adult stocks of commercially harvested shrimp, blue crabs, oysters, and other species throughout the United States are directly related to wetland quality and quantity (Turner and Boesch, 1988).

Wetlands throughout the United States have been and are being rapidly destroyed by human activities (e.g., flood control, agriculture, waste disposal, real estate development, shipping, commercial fishing, oil/gas exploration and production) and natural processes (e.g., sea-level rise, sediment compaction, droughts, hurricanes, floods). In the late 1970s and early 1980s, the country was losing wetlands at an estimated rate of 300,000 acres per year. The Clean Water Act, state wetland protection programs, and programs such as Swampbuster (USDA) have helped decrease wetland losses to an estimated 70,000 to 90,000 acres per year. Strong wetland protection is important nationally; otherwise, fisheries that support more than a million jobs and contribute billions of dollars to the national economy are at risk (Turner and Boesch, 1988; Stedman and Hanson, 2000), as are the ecological functions provided by wetlands (e.g., nursery areas, flood control, and water quality improvement).

Coastal wetlands, as defined here, include only estuarine and marine intertidal wetlands (e.g., salt and brackish marshes; mangroves and other shrub-scrub habitats; intertidal oyster reefs; and tidal flats, such as macroalgal flats, shoals, spits, and bars). This index does not include subtidal SAV, coral reefs, subtidal oyster reefs, worm reefs, artificial reefs, or freshwater/palustrine wetlands. It should be noted that the NWI data used in this assessment do not distinguish between the natural and created wetlands and that most created wetlands do not have all the functions of natural wetlands (NAS, 2001). For more information about wetlands, refer to EPA's wetlands Web site at http://www.epa.gov/owow/wetlands.

Because no new information on U.S. wetlands was available from the NWI, the assessment of coastal habitat from the NCCR II is used in this report. The NWI (Dahl, 2002) contains data on estuarine-emergent and tidal flat wetland acreage from 1990 and 2000 for all coastal states, except Hawaii and Puerto Rico. Data for Hawaii and Puerto Rico are only available for 1980 and 1990. The proportional change in regional coastal wetlands over the 10-year time period was determined for each region and combined with the long-term decadal loss rates for the period 1780 to 1990. The average of these two loss rates (historic and present) multiplied by 100 is the regional value of the coastal habitat index. The national value of the coastal habitat index is a weighted mean that reflects the extent of wetlands existing in each region (different than the distribution of the extent of coastal area). Table 1-19 shows the rating criteria used for the coastal habitat index.

Table 1-19. Criteria for Determining the Coastal Habitat Index

Rating	Criteria
Good	The index value is less than 1.0.
Fair	The index value is between 1.0 and 1.25.
Poor	The index value is greater than 1.25.

Coastal wetlands provide critical habitat for a variety of wildlife (courtesy of John Theilgard).

Highlight

An Index of Benthic Condition for the Coastal Acadian Biogeographic Province

Indices that combine several benthic community variables have been used by monitoring programs to measure the spatial extent of environmental problems, locate problem areas for further study, assess the effectiveness of remediation programs, and determine whether conditions are improving or deteriorating. For the NCCR II, the NCA used the Shannon-Wiener H' index, a measure of biodiversity, to evaluate the condition of benthic communities in the Acadian Province (Gulf of Maine). The Virginian Province Benthic Index (Paul et al., 2001) did not work well in this area, and at the time, there were not yet sufficient data to develop an index unique to the Acadian Province. Compared with the Virginian Province (the area from south of Cape Cod to Virginia), the Gulf of Maine is colder, deeper, better oxygenated, and more strongly flushed by tides. For the current report, NCA has used the 2000 and 2001 data to develop a specific Acadian Province Benthic Index (Hale and Heltshe, 2008).

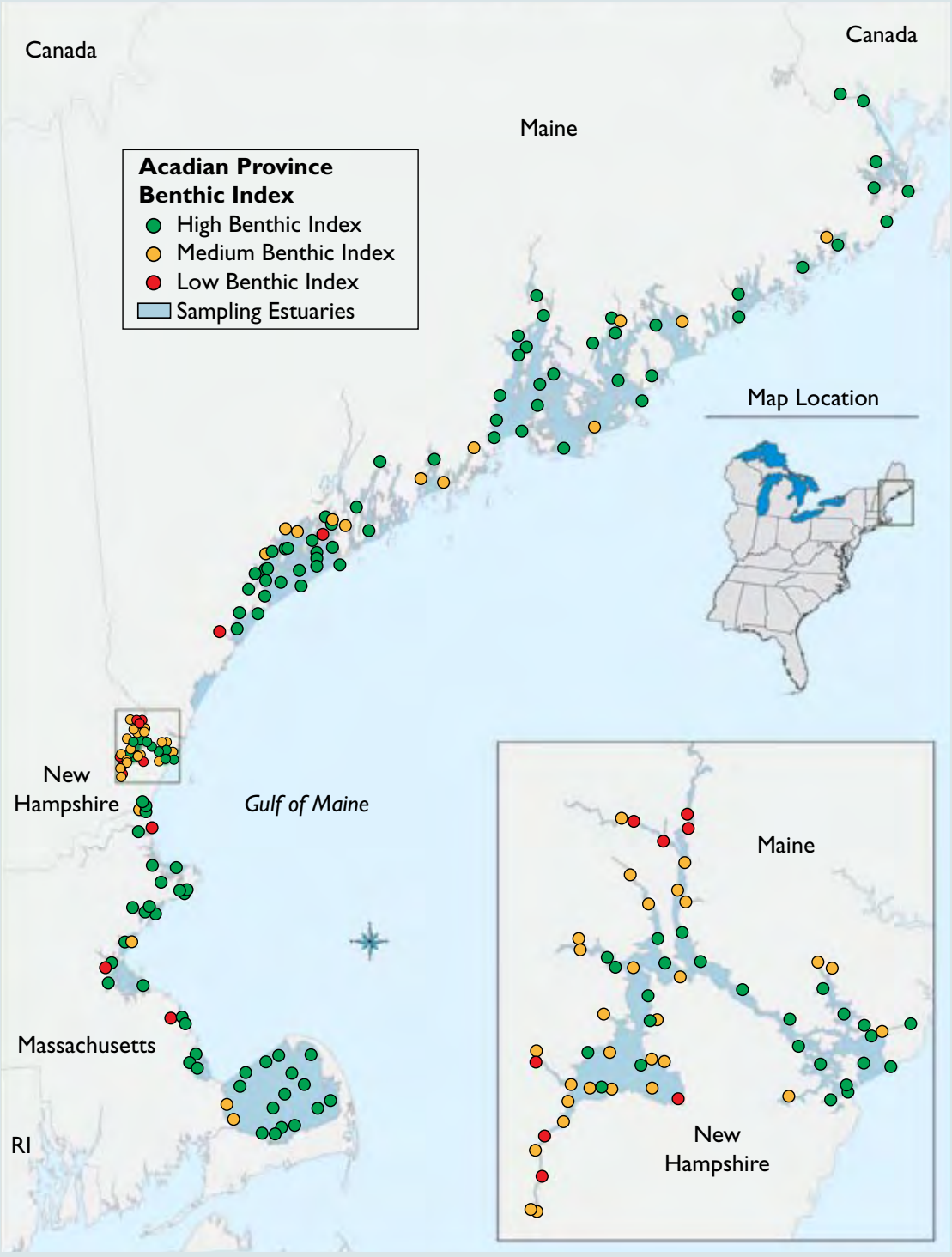
During the spring of 2004, the NCA held a workshop in Portsmouth, NH, with Gulf of Maine benthic ecologists to review candidate metrics, discuss preliminary indices, and learn about other available benthic data sets. First, the NCA identified the stations with the highest and lowest benthic environmental quality (BEQ). BEQ was defined as a function of nonbiological components, including sediment contaminant concentrations, sediment TOC levels, sediment toxicity, and concentrations of dissolved oxygen in bottom water. The aim was to use information from the benthic assemblage data to build an index that could discriminate stations with high and low BEQ. Using the scientific literature, the NCA developed a list of 40 possible candidates for benthic metrics that might be useful. These metrics included diversity measures and relative proportions of pollution-tolerant or pollution-sensitive taxa. The NCA used discriminant analysis with the candidate benthic metrics to identify those that had discriminatory power. These metrics were used to build discriminant functions. The discriminant functions that correctly classified at least 80% of the stations in the calibration data set became candidate benthic indices. Three independent data sets were used to validate the candidate indices and to select the best index. These data sets are the Massachusetts Water Resources Authority (MWRA) study of Boston Harbor and Massachusetts Bay (Williams et al., 2002), a study in Casco Bay (Larsen et al., 1983), and the NCA 2002 and 2003 data.

The discriminant function chosen as the Acadian Province Benthic Index for this report (see box) correctly classified 87.6% of the calibration data set and about three-quarters of the stations in the validation data sets. The map presents the classifications resulting from the application of this index at sampling sites within the Gulf of Maine in three categories: high, medium, and low. It should be noted that the NCA sampled few low- or intermediate-level saline estuaries in the Acadian Province, so the applicability of the current index in low-salinity areas is unknown. This index provides environmental managers with a way to assess the health of Gulf of Maine coastal benthic communities, both spatially and temporally. Further refinements and validations will be made as more NCA data become available.

Acadian Province Benthic Index = $0.494 \times Shannon + 0.670 \times MN\_ES50_{0.5} - 0.034 \times PctCapitellidae$

where

Shannon	=	Shannon-Wiener H' diversity index
MN_ES50$_{.05}$	=	Station mean of species tolerance values (Rosenberg et al., 2004)
PctCapitellidae	=	Percent abundance of capitellid polychaetes



Benthic index scores at monitoring sites from the validation data sets (U.S. EPA).

The NWI estimates represent regional assessments and do not apply to individual sites or individual wetlands. Before individual wetland sites can be assessed, rigorous methodologies for estimating the quantity and the quality of wetlands must be developed. Until these methods are available and implemented, only regional assessments of quantity losses can be made. Although a 1% loss rate per decade may seem small (or even acceptable), continued wetland losses at this rate cannot be sustained indefinitely and still leave enough wetlands to maintain their present ecological functions.

Fish Tissue Contaminants Index

Chemical contaminants may enter a marine organism in several ways: direct uptake from contaminated water, consumption of contaminated sediment, or consumption of previously contaminated organisms. Once these contaminants enter an organism, they tend to remain in the animal's tissues and may build up with subsequent feedings. When fish consume contaminated organisms, they may "inherit" the levels of contaminants in the organisms they consume. The same inheritance of contaminants occurs when humans consume fish with contaminated tissues. Contaminant residues can be examined in the fillets, whole-body portions, or specific organs of target fish and shellfish species and compared with risk-based EPA Advisory Guidance values (U.S. EPA, 2000c) for use in establishing fish advisories. EPA has also developed an Ambient Water Quality Criterion (AWQC) for methylmercury in fish and shellfish tissue (U.S. EPA, 2001e) and prepared draft guidance for implementing this AWQC (U.S. EPA, 2006a).

For the NCA surveys, both juvenile and adult target fish species were collected from all monitoring stations where fish were available, and whole-body contaminant burdens were determined. The target species typically included demersal (bottom-dwelling) and slower-moving pelagic (water column-dwelling) species that are representative of each of the geographic regions (Northeast Coast, Southeast Coast, Gulf Coast, West Coast, and Southcentral Alaska). These intermediate trophic-level (position in the food web) species are prey for larger predatory fish of commercial value (Harvey et al., 2008). Where available, 4 to 10 individual fish from each target species at each sampling site were analyzed by compositing fish tissues.

Although the EPA risk-based fish advisory recommendations were developed to evaluate the health risks of consuming market-sized fish fillets, they also may be used to assess the risk of whole-body contaminants in fish as a basis for estimating advisory determinations—an approach currently used by many state fish advisory programs (U.S. EPA, 2000c). These advisory values may also be used (as NCA uses them) as surrogate benchmark values to examine contaminants in non-commercial, juvenile and adult fish to compare levels of pollutant contamination across geographic regions and provide a national baseline assessment. The NCA compared whole-body contaminant concentrations in fish to the EPA-recommended values used by states as a basis for setting fish advisories for recreational fishers (Table 1-20) (U.S. EPA 2000c). The AWQC for methylmercury (U.S. EPA, 2001e) was not used in this assessment. Although EPA fish consumption recommendations are generally based on fillet tissue samples, they are also appropriate to compare to data from whole-fish or organ-specific body burdens that are used by many states for those fish consumers whose culinary practices include consumption of fish tissues other than the fillets. The whole-fish contaminant information collected by NCA for U.S. coastal waters was compared with risk-based threshold values based on a 154-pound adult human's consumption of four 8-ounce meals per month for selected contaminants (the approach used by most state fish advisory programs) and assessed for non-cancer and cancer health endpoints (U.S. EPA, 2000c). Table 1-21 shows the rating criteria for the fish tissue contaminants index for each station sampled, and Table 1-22 shows how these ratings were used to create a regional index rating.

Summary of Rating Criteria

The rating criteria used in this report are summarized in Table 1-23 (primary indices) and Tables 1-24 and 1-25 (component indicators).

Table 1-20. Risk-based EPA Advisory Guidance Values for Recreational Fishers (U.S. EPA, 2000c)

Contaminant	EPA Advisory Guidelines Concentration Range (ppm)[a]	Health Endpoint
Arsenic (inorganic)[b]	0.35–0.70	non-cancer
Cadmium	1.2–2.3	non-cancer
Mercury (methylmercury)[c]	0.12–0.23	non-cancer
Selenium	5.9–12.0	non-cancer
Chlordane	0.59–1.2	non-cancer
DDT	0.59–1.2	non-cancer
Dieldrin	0.059–0.12	non-cancer
Endosulfan	7.0–14.0	non-cancer
Endrin	0.35–0.70	non-cancer
Heptachlor epoxide	0.015–0.031	non-cancer
Hexachlorobenzene	0.94–1.9	non-cancer
Lindane	0.35–0.70	non-cancer
Mirex	0.23–0.47	non-cancer
Toxaphene	0.29–0.59	non-cancer
PAHs (benzo(a)pyrene)	0.0016–0.0032	cancer[d]
PCB	0.023–0.04	non-cancer

[a] Range of concentrations associated with non-cancer and cancer health endpoint risk for consumption of four 8-ounce meals per month.
[b] Inorganic arsenic concentrations were estimated to be 2% of the measured total arsenic concentrations (U.S. EPA, 2000a).
[c] The conservative assumption was made that all mercury is present as methylmercury because most mercury in fish and shellfish is present primarily as methylmercury and because analysis for total mercury is less expensive than analysis for methylmercury (U.S. EPA, 2000a).
[d] A non-cancer concentration range for PAHs does not exist.

Table 1-21. Criteria for Determining the Fish Tissue Contaminants Index by Station

Rating	Criteria
Good	For all chemical contaminants listed in Table 1-20, the measured concentrations in fish tissue fall below the range of the EPA Advisory Guidance* values for risk-based consumption associated with four 8-ounce meals per month.
Fair	For at least one chemical contaminant listed in Table 1-20, the measured concentration in fish tissue falls within the range of the EPA Advisory Guidance values for risk-based consumption associated with four 8-ounce meals per month.
Poor	For at least one chemical contaminant listed in Table 1-20, the measured concentrations in fish tissue exceeds the maximum value in the range of the EPA Advisory Guidance values for risk-based consumption associated with four 8-ounce meals per month.

*The EPA Advisory Guidance concentration is based on the non-cancer ranges for all contaminants except the concentration for PAHs (benzo(a)pyrene), which is based on a cancer range because a non-cancer range for PAHs does not exist (see Table 1-20).

Table 1-22. Criteria for Determining the Fish Tissue Contaminants Index by Region

Rating	Criteria
Good	Less than 10% of the fish samples analyzed (Northeast Coast region) or the monitoring stations where fish were caught (all other regions) are in poor condition, and more than 50% of the fish samples analyzed (Northeast Coast region) or the monitoring stations where fish were caught (all other regions) are in good condition.
Fair	10% to 20% of the fish samples analyzed (Northeast Coast region) or monitoring stations where fish were caught (all other regions) are in poor condition, or more than 50% of the fish samples analyzed (Northeast Coast region) or the monitoring stations where fish were caught (all other regions) are in combined poor and fair condition.
Poor	More than 20% of the fish samples analyzed (Northeast Coast region) or the monitoring stations where fish were caught (all other regions) are in poor condition.

Table 1-23. NCA Indices Used to Assess Coastal Condition

Icon		
 Water Quality Index	**Water Quality Index** – This index is based on measurements of five water quality component indicators (DIN, DIP, chlorophyll *a*, water clarity, and dissolved oxygen).	
	Ecological Condition by Site	**Ranking by Region**
	Good: No component indicators are rated poor, and a maximum of one is rated fair.	**Good**: Less than 10% of the coastal area is in poor condition, and more than 50% of the coastal area is in good condition.
	Fair: One component indicator is rated poor, or two or more component indicators are rated fair.	**Fair**: Between 10% and 20% of the coastal area is in poor condition, or more than 50% of the coastal area is in combined fair and poor condition.
	Poor: Two or more component indicators are rated poor.	**Poor**: More than 20% of the coastal area is in poor condition.
 Sediment Quality Index	**Sediment Quality Index** – This index is based on measurements of three sediment quality component indicators (sediment toxicity, sediment contaminants, and sediment TOC).	
	Ecological Condition by Site	**Ranking by Region**
	Good: No component indicators are rated poor, and the sediment contaminants indicator is rated good.	**Good**: Less than 5% of the coastal area is in poor condition, and more than 50% of the coastal area is in good condition.
	Fair: No component indicators are rated poor, and the sediment contaminants indicator is rated fair.	**Fair**: Between 5% and 15% of the coastal area is in poor condition, or more than 50% of the coastal area is in combined poor and fair condition.
	Poor: One or more component indicators are rated poor.	**Poor**: More than 15% of the coastal area is in poor condition.
 Benthic Index	**Benthic Index** (or a surrogate measure) – This index indicates the condition of the benthic community (organisms living in coastal sediments) and can include measures of benthic community diversity, the presence and abundance of pollution-tolerant species, and the presence and abundance of pollution-sensitive species.	
	Ecological Condition by Site	**Ranking by Region**
	Good, **fair**, and **poor** were determined using regionally dependent benthic index scores (see Table 1-18).	**Good**: Less than 10% of the coastal area is in poor condition, and more than 50% of the coastal area is in good condition.
		Fair: Between 10% and 20% of the coastal area is in poor condition, or more than 50% of the coastal area is in combined poor and fair condition.
		Poor: More than 20% of the coastal area is in poor condition.
 Coastal Habitat Index	**Coastal Habitat Index** – This index is evaluated using the data from the NWI (Dahl, 2002), which contains data on estuarine-emergent and tidal flat acreage for all coastal states (except Hawaii and Puerto Rico) for 1780 through 2000.	
	Ecological Condition by Site	**Ranking by Region**
	The average of the mean long-term, decadal wetland loss rate (1780–1990) and the present decadal wetland loss rate (1990–2000) was determined for each region of the United States and multiplied by 100 to create a coastal habitat index value.	**Good**: The coastal habitat index value is less than 1.0.
		Fair: The coastal habitat index value is between 1.0 and 1.25.
		Poor: The coastal habitat index value is greater than 1.25.
 Fish Tissue Contaminants Index	**Fish Tissue Contaminants Index** – This index indicates the level of chemical contamination in target fish/shellfish species.	
	Ecological Condition by Site	**Ranking by Region**
	Good: For all chemical contaminants listed in Table 1-20, the measured concentrations in tissue fall below the range of the EPA Advisory Guidance* values for risk-based consumption associated with four 8-ounce meals per month.	**Good**: Less than 10% of the fish samples analyzed (Northeast Coast region) or the monitoring stations where fish were caught (all other regions) are in poor condition, and more than 50% of the fish samples analyzed (Northeast Coast region) or the monitoring stations where fish were caught (all other regions) are in good condition.
	Fair: For at least one chemical contaminant listed in Table 1-20, the measured concentration in tissue falls within the range of the EPA Advisory Guidance values for risk-based consumption associated with four 8-ounce meals per month.	**Fair**: 10% to 20% of the fish samples analyzed (Northeast Coast region) or the monitoring stations where fish were caught (all other regions) are in poor condition, or more than 50% of the fish samples analyzed (Northeast Coast region) or the monitoring stations where fish were caught (all other regions) are in combined poor and fair condition.
	Poor: For at least one chemical contaminant listed in Table 1-20, the measured concentration in tissue exceeds the maximum value in the range of the EPA Advisory Guidance values for risk-based consumption associated with four 8-ounce meals per month.	**Poor**: More than 20% of the fish samples analyzed (Northeast Coast region) or the monitoring stations where fish were caught (all other regions) are in poor condition.

*The EPA Advisory Guidance concentration is based on the non-cancer ranges for all contaminants except for PAHs (benzo(a)pyrene), which is based on a cancer range because a non-cancer range for PAHs does not exist (see Table 1-20).

Table 1-24. NCA Criteria for the Five Component Indicators Used in the Water Quality Index to Assess Coastal Condition

Dissolved Inorganic Nitrogen (DIN)

Ecological Condition by Site	Ranking by Region
Good: Surface concentrations are less than 0.1 mg/L (Northeast, Southeast, Gulf), 0.5 mg/L (West, Alaska), or 0.05 mg/L (tropical*).	**Good**: Less than 10% of the coastal area is in poor condition, and more than 50% of the coastal area is in good condition.
Fair: Surface concentrations are 0.1–0.5 mg/L (Northeast, Southeast, Gulf), 0.5–1.0 mg/L (West, Alaska), or 0.05–0.1 mg/L (tropical).	**Fair**: 10% to 25% of the coastal area is in poor condition, or more than 50% of the coastal area is in combined fair and poor condition.
Poor: Surface concentrations are greater than 0.5 mg/L (Northeast, Southeast, Gulf), 1.0 mg/L (West, Alaska), or 0.1 mg/L (tropical).	**Poor**: More than 25% of the coastal area is in poor condition.

Dissolved Inorganic Phosphorus (DIP)

Ecological Condition by Site	Ranking by Region
Good: Surface concentrations are less than 0.01 mg/L (Northeast, Southeast, Gulf), 0.01 mg/L (West, Alaska), or 0.005 mg/L (tropical).	**Good**: Less than 10% of the coastal area is in poor condition, and more than 50% of the coastal area is in good condition.
Fair: Surface concentrations are 0.01–0.05 mg/L (Northeast, Southeast, Gulf), 0.01–0.1 mg/L (West, Alaska), or 0.005–0.01 mg/L (tropical).	**Fair**: 10% to 25% of the coastal area is in poor condition, or more than 50% of the coastal area is in combined fair and poor condition.
Poor: Surface concentrations are greater than 0.05 mg/L (Northeast, Southeast, Gulf), 0.1 mg/L (West, Alaska), or 0.01 mg/L (tropical).	**Poor**: More than 25% of the coastal area is in poor condition.

Chlorophyll *a*

Ecological Condition by Site	Ranking by Region
Good: Surface concentrations are less than 5 µg/L (less than 0.5 µg/L for tropical ecosystems).	**Good**: Less than 10% of the coastal area is in poor condition, and more than 50% of the coastal area is in good condition.
Fair: Surface concentrations are between 5 µg/L and 20 µg/L (between 0.5 µg/L and 1 µg/L for tropical ecosystems).	**Fair**: 10% to 20% of the coastal area is in poor condition, or more than 50% of the coastal area is in combined fair and poor condition.
Poor: Surface concentrations are greater than 20 µg/L (greater than 1 µg/L for tropical ecosystems).	**Poor**: More than 20% of the coastal area is in poor condition.

Water Clarity

Ecological Condition by Site	Ranking by Region
Good: Amount of light at 1 meter is greater than 10% (coastal waters with high turbidity), 20% (coastal waters with normal turbidity), or 40% (coastal waters that support SAV) of surface illumination.	**Good**: Less than 10% of the coastal area is in poor condition, and more than 50% of the coastal area is in good condition.
Fair: Amount of light at 1 meter is 5–10% (coastal waters with high turbidity), 10–20% (coastal waters with normal turbidity), or 20–40% (coastal waters that support SAV) of surface illumination.	**Fair**: 10% to 25% of the coastal area is in poor condition, or more than 50% of the coastal area is in combined fair and poor condition.
Poor: Amount of light at 1 meter is less than 5% (coastal waters with high turbidity), 10% (coastal waters with normal turbidity), or 20% (coastal waters that support SAV) of surface illumination.	**Poor**: More than 25% of the coastal area is in poor condition.

Dissolved Oxygen

Ecological Condition by Site	Ranking by Region
Good: Bottom-water concentrations are greater than 5 mg/L.	**Good**: Less than 5% of the coastal area is in poor condition, and more than 50% of the coastal area is in good condition.
Fair: Bottom-water concentrations are between 2 mg/L and 5 mg/L.	**Fair**: 5% to 15% of the coastal area is in poor condition, or more than 50% of the coastal area is in combined fair and poor condition.
Poor: Bottom-water concentrations are less than 2 mg/L.	**Poor**: More than 15% of the coastal area is in poor condition.

*Tropical ecosystems include Hawaii, Puerto Rico, and Florida Bay sites.

Table 1-25. NCA Criteria for the Three Component Indicators Used in the Sediment Quality Index to Assess Coastal Condition

Sediment Toxicity is evaluated as part of the sediment quality index using a 10-day static toxicity test with the organism *Ampelisca abdita*.

Ecological Condition by Site	Ranking by Region
Good: Mortality* is less than or equal to 20%.	**Good**: Less than 5% of the coastal area is in poor condition.
Poor: Mortality is greater than 20%.	**Poor**: 5% or more of the coastal area is in poor condition.

Sediment Contamination is evaluated as part of the sediment quality index using ERM and ERL values.

Ecological Condition by Site	Ranking by Region
Good: No ERM values are exceeded, and fewer than five ERL values are exceeded.	**Good**: Less than 5% of the coastal area is in poor condition.
Fair: No ERM values are exceeded, and five or more ERL values are exceeded.	**Fair**: 5% to 15% of the coastal area is in poor condition.
Poor: One or more ERM values are exceeded.	**Poor**: More than 15% of the coastal area is in poor condition.

Sediment Total Organic Carbon (TOC)

Ecological Condition by Site	Ranking by Region
Good: The TOC concentration is less than 2%.	**Good**: Less than 20% of the coastal area is in poor condition.
Fair: The TOC concentration is between 2% and 5%.	**Fair**: 20% to 30% of the coastal area is in poor condition.
Poor: The TOC concentration is greater than 5%.	**Poor**: More than 30% of the coastal area is in poor condition.

*Test mortality is adjusted for control mortality.

How the Indices Are Summarized

Overall condition for each region was calculated by summing the scores for the available indices and dividing by the number of available indices (i.e., equally weighted), where good = 5; good to fair = 4; fair = 3; fair to poor = 2; and poor = 1. In calculating the overall condition score for a region, the indices are weighted equally because of the lack of a defendable, more-than-conceptual rationale for uneven weighting. The Southeast Coast region, for example, received the following scores:

Indices	Score
Water Quality Index	3
Sediment Quality Index	3
Benthic Index	5
Coastal Habitat Index	3
Fish Tissue Contaminants Index	4
Total Score Divided by 5 = Overall Score	18/5 = 3.6

The overall condition and index scores for the nation are calculated based on a weighted average of the regional scores for each index. The national ratings for overall condition and each index are then assigned based on these calculated scores, rather than on the percentage of area in good, fair, or poor condition. The indices were weighted based on the coastal area contributed by each geographic area. For example, the weighted average for the water quality index was calculated by summing the products of the regional water quality index scores and the area contributed by each region (Figure 1-4). These weighting factors were used for all indices except the coastal habitat index, which used the geographic distribution of total area of coastal wetlands (Figure 1-5). The national overall condition score was then calculated by summing each national index score and dividing by five. Additional discussion of this process is presented in Appendix A.

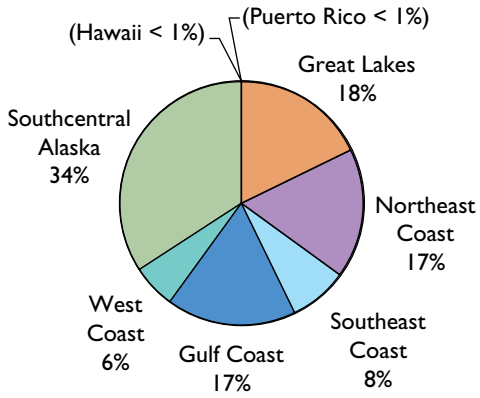


Figure 1-4. Percentage of coastal area contributed by each geographic region assessed in this report (U.S. EPA/NCA).

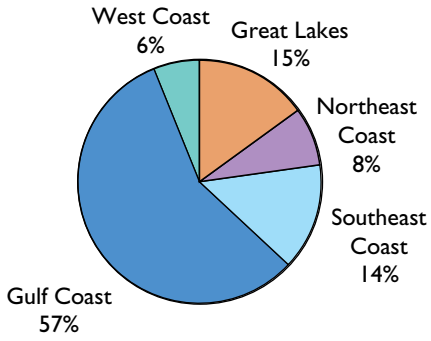


Figure 1-5. Percentage of coastal wetland area contributed by each geographic region assessed in this report (U.S. EPA/NCA).

The snowy grouper (*Epinephelus niveatus*) commercial fishery is managed by the South Atlantic Fishery Management Council (SAFMC) and is subject to limited-access permit requirements and gear restriction (courtesy of Andrew Davis, NOAA, and Lance Horn, University of North Carolina Wilmington).

Large Marine Ecosystem Fisheries Data

In addition to coastal monitoring data, a second type of data used to assess coastal condition in this report is LME fisheries data from the NMFS. LMEs are areas of ocean characterized by distinct bathymetry, hydrography, productivity, and trophic relationships. LMEs extend from river basins and estuaries to the seaward boundaries of continental shelves and the outer margins of major current systems. Within these waters, ocean pollution, fishery overexploitation, and coastal habitat alteration are most likely to occur. Sixty-four LMEs surround the continents and most large islands and island chains worldwide and produce 95% of the world's annual marine fishery yields; 10 of these LMEs are found in waters adjacent to the conterminous United States, Alaska, Hawaii, Puerto Rico, and U.S. island territories (NOAA, 1988; 2007g).

The NMFS fisheries data were organized by LME to allow readers to more easily consider fisheries and coastal condition data together. These data are more comparable using LMEs for several reasons. Geographically, LMEs contain both the coastal waters assessed by NCA and the U.S. Exclusive Economic Zone (EEZ) waters containing the fisheries assessed by NMFS. In addition, the borders of the LMEs coincide roughly with the borders of the NCA regions. When considered together, these two data sets provide insight into the condition of U.S. marine waters, especially considering how closely the areas covered by these data sets are related.

This report presents the offshore fisheries data by LME through 2004. This index period was limited to 2004 because this timeframe is more consistent with the coastal condition and advisory data presented in this report. This temporal consistency allows the reader to consider all three types of data together to get a clearer "snapshot" of conditions in U.S. coastal waters.

Interactions Between Fisheries and Coastal Condition

Freshwater and saltwater coastal areas are constantly changing as a result of both human and natural forces, which make these areas both resilient and fragile in nature (National Safety Council, 1998). The ecosystems in these areas are interconnected, and stressors on one of these systems can affect the other systems. For example, water quality in freshwater streams and rivers is vital to providing a healthy environment, particularly for anadromous (migratory) fish species such as salmon that are born in freshwater streams, migrate to the ocean as juveniles, utilize the ocean environment as they mature into adults, and return to the streams of their birth to spawn and ultimately die. Good water quality in the spawning areas is required to ensure development of the young. Good water quality is also important for the species that are spawned and develop as juveniles in estuaries, where fresh and salt waters mingle, interact, and are refreshed with the tidal change. When water quality in these upstream freshwater areas is negatively impacted, the survival of juvenile fish in the estuarine nursery areas may decrease, ultimately affecting the offshore fishery stocks of adults for these species.

The coastal and offshore waters, as well as the resources they contain, face many stressors. For example, land-based stressors include increasing coastal population growth coupled with inadequate land-use planning and increasing inputs of pollutants from the development of urban areas and from agricultural and industrial activities. Pollutant inputs to our freshwater, estuarine, and near-coastal waters include excessive amounts of nutrients from land runoff; toxic chemical contaminants discharged from point sources; nonpoint-source runoff; accidental spills; and deposition from the atmosphere. Degradation or loss of habitat (e.g., loss of wetland acreage), episodes of hypoxia, and pressures from overfishing by both recreational and commercial fisherman

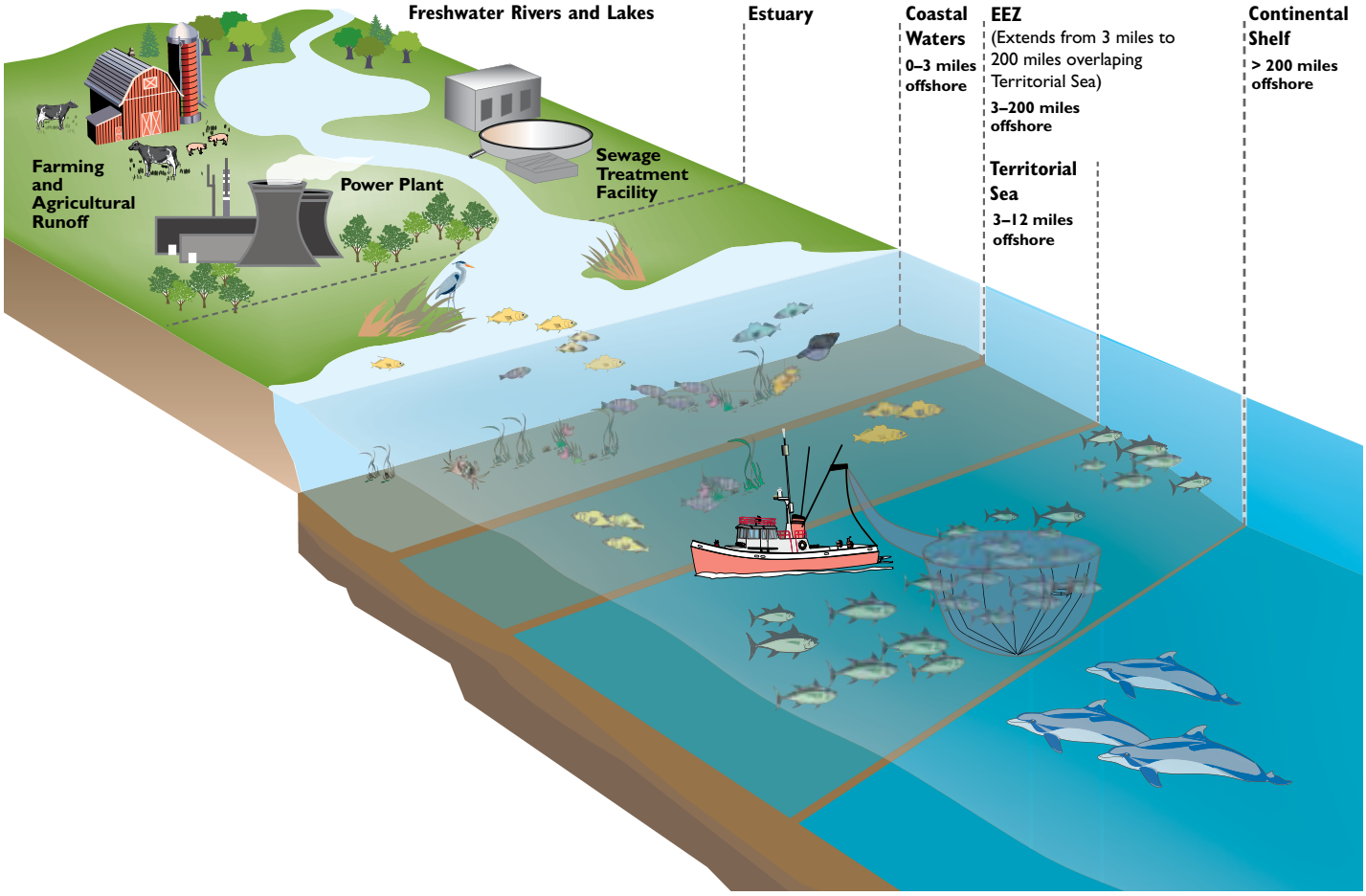


Figure 1-6. Linkages between the stressors in freshwater systems, estuaries, and the coastal ocean (U.S. EPA/NCA).

also impact these coastal ecosystems and the species they nurture. Offshore in the EEZ, stressors come from oil spills, overexploitation of fishery stock resources, and/or habitat loss associated with damage to benthic communities (e.g., macroalgal forests and coral reefs) from fishing activities or development of mineral and energy resources.

The linkage between the stressors in the freshwater rivers and estuaries and the coastal ocean is shown in Figure 1-6. Aquatic and estuarine fisheries resource managers direct their efforts to preserving water quality conditions; maintaining important spawning and nursery areas associated with wetlands, marshes, and SAV beds; and regulating fishing pressure by recreational and commercial fishermen. In contrast, offshore fisheries managers direct their efforts to managing the exploitation of commercial fishery resources of the adult stocks. Outside the EEZ, fisheries managers have less control over the fishery stocks unless established by international treaties. These combined efforts to reduce pollution, maintain habitat quality, and manage fisheries help to ensure that healthy fishery stocks can be maintained for many years into the future.

Fishery Management and Assessment

Ultimately, the Secretary of Commerce has management responsibility for most marine life in U.S. waters and has entrusted the management of these resources to NOAA's NMFS. Most of the NMFS's management and conservation responsibilities are derived from the following acts of Congress:

- Magnuson-Stevens Fishery Conservation and Management Act regulates fisheries within the EEZ
- Endangered Species Act (ESA) protects species that are in danger of extinction or likely to become an endangered species
- Marine Mammal Protection Act regulates the taking of marine mammals
- Fish and Wildlife Coordination Act authorizes the collection of fisheries data and coordination with other agencies for environmental decisions affecting fisheries management regions
- Federal Power Act provides concurrent responsibilities with the FWS on protecting aquatic habitat (NMFS, In press).

The NMFS regulates fisheries in the waters located 3 to 200 nautical miles offshore of the United States in an area known as the EEZ. The waters located landward of the EEZ (0–3 nautical miles offshore) are managed by coastal states and multistate fisheries commissions. Fishery resources in the EEZ are managed largely through fishery management plans (FMPs). FMPs may be developed by the NMFS or by fishery management councils (e.g., Pacific Fishery Management Council, New England Fishery Management Council, Gulf of Mexico Fishery Management Council) through extensive consultation with state and federal agencies, affected industry sectors, public interest groups, and, in some cases, international science and management organizations (NMFS, In press).

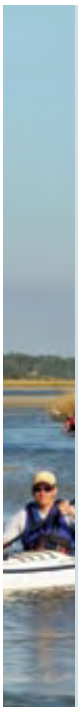
Various data sources are used to assess fishery stocks in the EEZ. Catch-at-age fisheries data are reported to the NMFS by commercial and recreational fisheries on the quantity of fish caught, the individual sizes of fish and their basic biological characteristics (e.g., age, sex, maturity), the ratio of fish caught to time spent fishing (i.e., catch per unit effort [CPUE]), and other factors. The NMFS also conducts direct resource surveys using specialized fishery research vessels to calculate the abundance index (i.e., estimated population size) for some species. The NMFS analyzes these data using several metrics to gain an understanding of the status and trends in U.S. fishery stocks. These metrics include

- **Landings/Catch**—*Landings* are the number or pounds of fish unloaded at a dock by commercial fishermen or brought to shore by recreational fishermen for personal use. Landings are reported at the points where fish are brought to shore. *Catch* is the total number or pounds of fish captured from an area over some period of time. This measure includes fish that are caught, but released or discarded. The catch may take place in an area different from where the fish are landed.
- **Fishing Mortality Rate**—The *fishing mortality rate* is the rate at which members of the population perish due to fishing activities.

- **Yields (various)**—The *maximum sustainable yield* is the largest average catch or yield that can continuously be taken from a stock under existing environmental conditions. The *recent average yield* is the average reported fishery landings for a recent timeframe. The *long-term potential yield* is the maximum long-term average yield that can be achieved through conscientious stewardship. The *near-optimum yield* is based on the maximum sustainable yield as modified by economic, social, or ecological factors to provide the greatest overall benefit to the nation with particular consideration for food production and recreational opportunities.
- **Overfishing/Overfished**—According to the Magnuson-Stevens Fishery Conservation and Management Act of 1996, a fishery is considered *overfished* if the stock size is below a minimum threshold, and *overfishing* is occurring if a stock's fishing mortality rate is above a maximum level. These thresholds and levels are associated with maximum sustainable yield-based reference points and vary between individual stocks, stock complexes, and species of fish.
- **Utilization**—The degree of *utilization* is determined by comparing the present levels of fishing effort and stock abundance to those levels necessary to achieve the long-term potential yield. A fishery can be classified as underutilized, fully utilized, overutilized, or unknown (NMFS, In press).

Once the status of a fishery is assessed, resource managers may employ various management tools to regulate where, when, and how people fish, thus protecting and sustaining our nation's fishery resources so that marine resources continue as functioning components of marine ecosystems, afford economic opportunities, and enhance the quality of life for U.S. citizens (NOAA, 2007c). When deemed necessary, fishery resource managers can employ a variety of different tools to regulate harvest depending on the fish or shellfish species involved. These fishery management tools include the following:

- **Daily bag or trip catch limits** that reduce or increase the number of fish caught per day or per trip, respectively



Marine Fisheries Fuel the U.S. Economy

More than one-fifth of the world's most productive marine waters lie within the LMEs of the EEZ. The value of both commercial and recreational fishing is significant to the U.S. economy, thousands of private firms, and individuals, families, and communities. In 2004

- U.S. commercial fishermen landed 9.6 billion pounds of fish and shellfish, valued at $3.7 billion (Figure 1-7).
- The commercial marine fishing industry contributed an estimated $31.6 billion (in value added) to the nation's GNP.
- U.S. consumers spent an estimated $61.9 billion for fishery products (NMFS, 2005c).

- **Size limits** that impose minimum fish lengths that limit harvest to adults, thereby protecting immature or juvenile fish
- **Seasonal closures** that prohibit commercial and/or recreational harvesting of specific fish or shellfish stocks during the spawning period
- **Limited access programs** that prevent increased fishing participation by reducing the number of fishing vessels through vessel buy-out programs, placing a moratorium on new vessel entrants into a fishery, or establishing a permitting system for commercial fishermen
- **Gear restrictions** that limit the use of certain types of equipment or mandate increases in regulated mesh size, thereby protecting the habitat from damage or excluding juveniles from harvesting through the use of larger mesh sizes, respectively
- **Time and area closures** that prohibit harvesting of specific fish stocks in specific fishing grounds or limit the allowable number of days at sea for fishing for certain types of vessels (e.g., trawl or gill-net) to protect habitat of juveniles or spawning species or to reduce total catch

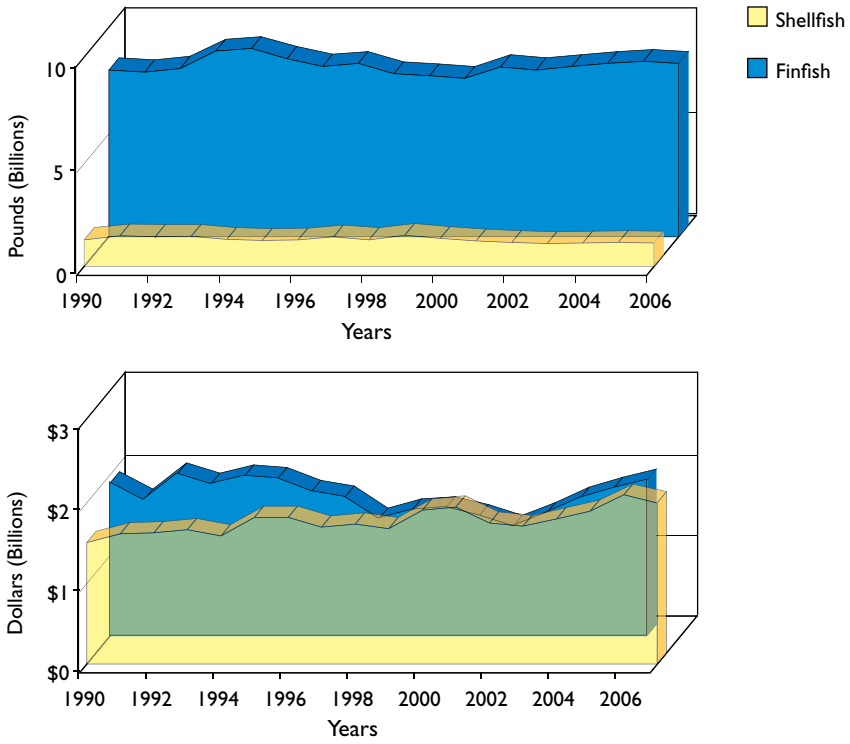


Figure 1-7. Volume and value of commercial fisheries landings, 1990–2006 (NMFS, 2007).

- **Harvest quotas** that limit the number of fish of a particular species that can be harvested annually from a particular region, thereby preventing overfishing
- **Establishment of Marine Protected Areas** within which the harvest of all species is prohibited.

Through the use of these fishery management tools, the NMFS makes stewardship decisions and provides support for rebuilding stocks through science-based conservation and resources management to ensure that marine fishery resources continue as healthy, sustainable, and functioning components of marine ecosystems (NOAA, 2007c). Unless otherwise noted, the information provided for this report on living marine resources within U.S. LMEs was compiled from the NMFS productivity data and the report *Our Living Oceans* (NMFS, In press), which is issued periodically by the NMFS and covers most living marine resources of interest for commercial, recreational, subsistence, and aesthetic or intrinsic reasons to the United States.

Assessment and Advisory Data

Assessment and advisory data provided by states or other regulatory agencies are the third set of data used in this report to assess coastal condition. Several EPA programs, including the Clean Water Act Section 305(b) Assessment Program, the National Listing of Fish Advisories (NLFA) Program, and the Beaches Environmental Assessment, Closure, and Health (BEACH) Program, maintain databases that are repositories for information about how well coastal waters support their designated or desired uses. These uses are important factors in the public's perception of coastal condition and also address the condition of the coast as it relates to public health. The data for these programs are collected by multiple state agencies and reported to EPA, and data collection and reporting methods differ among states. In addition, advisories are precautionary and may not reflect regional condition. Because of these inconsistencies, data generated by these programs are not included in and are not comparable to the regional estimates of coastal condition.

Clean Water Act Section 305(b) Assessments

States report water quality assessment information and water quality impairments under Section 305(b) of the Clean Water Act. States and tribes rate water quality by comparing measured values to their state and tribal water quality standards. The 305(b) assessment ratings (submitted by the states in 2002) are stored in EPA's National Assessment Database (NAD) and are useful for evaluating the success of state water quality improvement efforts; however, it should be emphasized that each state monitors water quality parameters differently, so it is difficult to make generalized statements about the condition of the nation's coastal waters based on these data alone. For the 2002 reporting cycle, several states and island territories with estuarine and coastal marine waters did not submit 305(b) assessment information to EPA. For the states of North Carolina and Washington, as well as the island territories of American Samoa, Guam, and the Northern Mariana Islands, no data were available for the 2002 reporting cycle in the NAD. Because the reporting of 305(b) information was not complete for all coastal states and territories, it was decided that this information would not be summarized for inclusion in the NCCR III. For this report, only data from EPA's NLFA database and the BEACH PRogram tracking, beach Advisories, Water quality standards, and Nutrients (PRAWN) database are presented for calendar year 2003.

How the NCA fish tissue contaminants index differs from the state fish advisory data

The results of the NCA fish tissue contaminants index provide a different picture of chemical contamination in fish than the results obtained from the state fish consumption advisory programs. The main difference between these two programs is that the NCA is designed to be a nationally consistent *ecological* assessment of contaminant concentrations in fish tissue in a variety of *ecologically* important target species. In contrast, the state fish advisory programs are designed to identify fish tissue contaminant concentrations in fish species that are locally consumed by recreational fishers that may be harmful to *human health* and warrant issuance of a fish advisory. These programs differ in several other ways, including the contaminants analyzed, type of fish samples analyzed, and health benchmarks used in the assessment. These differences are discussed in greater detail below and are summarized in the table.

- The NCA analyzes each fish sample for a uniform suite of contaminants in all estuaries nationally. In contrast, individual states monitor for specific contaminants, but each state selects the contaminants of concern for a particular waterbody based on land-use practices in the watershed, identified sources of pollution, and available state resources. Therefore, some states may monitor for mercury and pesticides, while other states monitor for select heavy metals and PCBs.
- The NCA analyzes both juvenile and adult fish, most often as whole specimens, because this is the way fish would typically be consumed by predator species. This approach is appropriate for an ecological assessment. In contrast, most state programs assess the risk of contaminant exposure to human populations and, therefore, analyze primarily the fillet tissue (portion most commonly consumed by the general population). States may also conduct chemical analyses of whole fish or species organs in areas where certain populations such as Native Americans, Southeast Asians, or other ethnic groups consume whole fish or other fish tissues. The use of whole-fish samples can result in higher concentrations of those contaminants (e.g., DDT, PCBs, dioxins and other chlorinated pesticides) that are stored in fatty tissues and lower concentrations of contaminants (e.g., mercury) that accumulate primarily in the muscle tissue. In contrast, the states' practice of typically analyzing fillet samples can result in higher concentrations of those contaminants that tend to concentrate in the muscle tissue and lower concentrations of those contaminants that are typically stored in fatty tissues, which are not included in a fillet sample.

(continued)

How the NCA fish tissue contaminants index differs from the fish advisory data (continued)

- The NCA analyzes fish from a variety of species from intermediate trophic levels found in estuaries and coastal marine waters; these species are often prey species for many commercially valuable predator species. In addition, the NCA analyzes both juvenile and adult fish. In contrast, state programs typically analyze only the larger marketable-sized specimens (adults) of the fish or shellfish species that are consumed by members of the local population for making fish advisory determinations. These fish species are often predators (e.g., bluefish, striped bass, king mackerel) at the top of the estuarine or coastal food web and are more likely to have bioaccumulated higher concentrations of contaminants than some of the target species sought by the NCA program.

Summary of Differences Between State Fish Consumption Advisory Programs and NCA Fish Sampling Approach

Elements	State Fish Advisory Programs	NCA
Fish species and sizes sampled	Sample marketable-sized adult fish with a focus on those species consumed by the local fish-eating population.	Samples target species (unique to each geographic region) that includes demersal or slow-moving pelagic species from intermediate trophic levels, including all sizes and ages (juveniles and adults) of fish in an ecosystem.
Type of fish samples analyzed	Analyze primarily fillet tissue samples (edible portion) to assess human health concerns. Analysis of whole-body fish or other tissue types is conducted when the local consumer's culinary preference is to eat whole fish or body parts other than the fillet sample.	Analyzes primarily whole-body samples to assess the health of the ecosystem. Some fish fillet sampling has been conducted and will be conducted in future assessments.
Number and sample types analyzed	Analyze chemical contaminant residues in both individual fish and composite samples of varying numbers of adult fish. The number of fish used per composite is set by the state conducting the analyses.	Typically analyzes chemical contaminant residues in composite samples of fish of the same species. Composite samples may contain 4 to10 juvenile and adult fish.
Contaminants analyzed in tissues	Individual states monitor for any contaminant or suite of contaminants that are of concern to human health in a particular waterbody in their jurisdiction. The extent of analyses is often dependent on available state resources.	Monitors for a specific suite of contaminants at all sites nationally including the following: 23 PAH compounds, 21 PCB congeners, 6 DDT derivatives and metabolites, 14 chlorinated pesticides (other than DDT), and 3 metals (including mercury).
Health benchmark values used	Use EPA-recommended fish consumption advisory values to identify fish species of human health concern and to develop fish advisories.	Uses EPA-recommended fish consumption advisory values as surrogate values to assess health of the ecosystem.

National Listing of Fish Advisories

States, U.S. territories, and tribes have primary responsibility for protecting their residents from the health risks of consuming contaminated, non-commercially caught fish and shellfish. Resource managers at the state, territory, or tribal level protect residents by issuing consumption advisories for the general population, including recreational and subsistence fishers, as well as for sensitive groups (e.g., pregnant women, nursing mothers, children, and individuals with compromised immune systems). These advisories inform the public that high concentrations of chemical contaminants (e.g., mercury or PCBs) have been found in local fish and shellfish. The advisories include recommendations to limit or avoid consumption of certain fish and shellfish species from specific waterbodies or, in some cases, from specific waterbody types (e.g., all coastal waters within a state).

The 2003 NLFA is a database—available from EPA and searchable on the Internet at http://www.epa.gov/waterscience/fish—that contains fish advisory information provided to EPA by the states and tribes. The NLFA database can generate national, regional, and state maps that illustrate any combination of advisory parameters.

Beach Advisories and Closures

There is growing concern in the United States about public health risks posed by polluted bathing beaches. Scientific evidence documenting the rise of infectious diseases caused by microbial organisms in recreational waters continues to grow; however, not enough information is currently available to define the extent of beach pollution throughout the country. EPA's BEACH Program, established in 1997, is working with state and local governments to compile information on beach pollution that will help define the national extent of the problem.

From 1997 through 2002, beach monitoring data were collected and submitted to EPA on a voluntary basis. During this time, sampled areas included coastal, Great Lakes, and some inland waters. Beginning with the 2003 season, the BEACH Act required that states submit data to EPA for beaches that are in coastal and Great Lakes waters and for all other beaches, as available. Due to these new reporting requirements, the 2003 and 2004 data cannot easily be compared to data gathered from 1997 through 2002, and long-term patterns are difficult to analyze.

A few states have comprehensive beach monitoring programs to test the safety of water for swimming. Many other states have only limited beach monitoring programs, and some states have no monitoring programs linked directly to water safety at swimmable beaches. The number of beach closings and swimming advisories that continue to be issued annually, however, indicate that beach pollution is a persistent problem. In 2003, there were 839 beaches with at least one closure or advisory in coastal and Great Lakes waters (U.S. EPA, 2006c).

Connections with Human Uses

The first eight chapters of this report address the condition of the nation's coastal waters in terms of how well these waters meet ecological criteria. A related, but separate consideration is how well coasts are meeting human expectations in terms of the services they provide for transportation, development, fishing, recreation, and other uses. Human use does not necessarily compromise ecological condition, but there are inherent conflicts between human activities that alter the natural state of the coast (e.g., marine transportation) and activities (e.g., fishing) that rely on the bounty of nature. In Chapter 9 of this report, the emphasis is on the human uses of a particular estuary—Narragansett Bay in Rhode Island and Massachusetts—and how well these uses are met. Because this approach relies on local information, it can be pursued only at the level of an individual estuary. The corresponding chapter in the NCCR II centered on Galveston Bay, TX. The choice of Narragansett Bay is to a large extent dictated by the availability of long-term data on the abundance of commercial and recreational fish for this estuary. Fishing is not the only human use of an estuary, but it is an important use thought to be strongly connected with ecological indicators.